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Mountain Pine Beetle Conditions in Whitebark Pine Stands in the Greater Yellowstone Ecosystem, 2006

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Introduction

Mountain pine beetle, *Dendroctonus ponderosae* Hopkins, (MPB) populations are currently at outbreak status in many parts of the intermountain West. More than one million acres of host stands are infested to some extent in the Northern Region alone. Most infested acres are in lodgepole pine stands; however, almost 143,000 of them are in whitebark pine (WBP). In the Northern Region, unusually high amounts of MPB-infested WBP stands are found in northern Idaho and west-central Montana in addition to forests in southwestern Montana, and Yellowstone National Park (NP)—the latter a part of the Greater Yellowstone Ecosystem (GYE).

In 2005, we recorded the highest level of MPB-caused WPB mortality in any one year for which we have data. Unpublished office reports indicate a similar series of outbreaks existed in the 1930s—another period of unusually warm temperatures—in Southeastern Idaho, Southwestern Montana and Yellowstone NP; but we have no records documenting the extent of those outbreaks. By most accounts, those outbreaks were probably at least as extensive as current ones. So, while present outbreaks are devastating and unusual; they are likely not unprecedented.

In the GYE, defined as Yellowstone and Grand Teton NPs and surrounding national forests in the Northern, Intermountain, and Rocky Mountain Regions (Gallatin, Beaverhead, Custer, Bridger-Teton, Caribou-Targhee, and Shoshone National Forests [NF]), there are approximately 1,064,600 acres of WBP-dominated forested stands. At present, about 171,200 (16%) of those acres contain some level of MPB-caused mortality, recorded in 2005 during annual aerial-detection surveys (ADS) (Figure 1). Nearly 720,000 WBP were estimated as having been killed in 2004, recorded as faders in 2005 (Meyer 2006; Halsey and Ross, personal communication) (Table 1).

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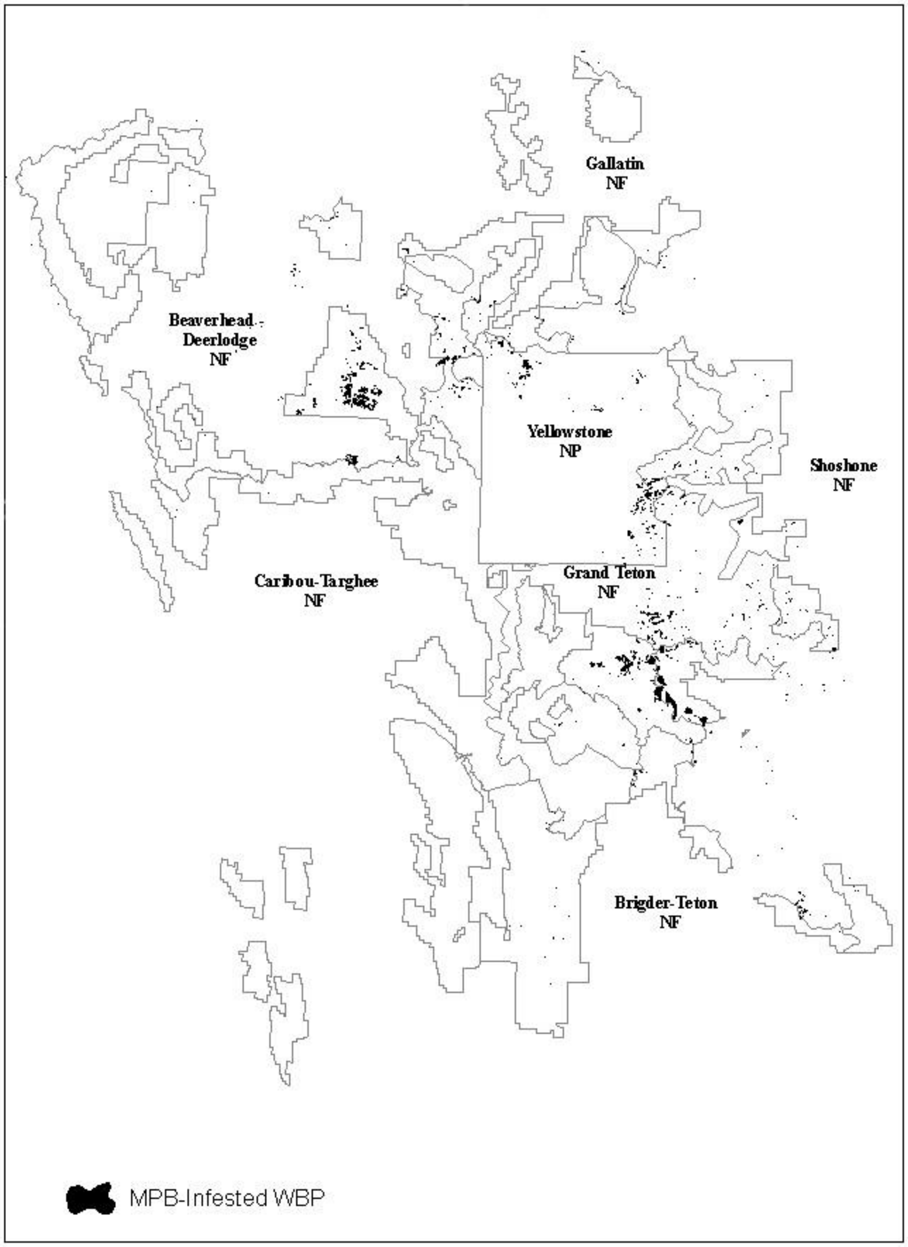

Figure 1. MPB-infested WBP stands in the GYE, 2005 (ADS data)

I should note, many WBP sites are in wilderness areas or parks not routinely surveyed. The following tables show a few administrative units for which we have no data ("Not flown"). That should not be interpreted as areas in which outbreaks do not exist. Rather, they are reporting areas not surveyed.

Table 1. MPB-Infested WBP, Acres and Trees, GYE; Recorded in 2005 (ADS Data)

Administrative Unit	Acres of WBP	MPB-Infested Acres (2005)	Estimated Faders	Average Trees/Acre
Yellowstone NP	218,700	29,215	365,200	12.5
Grand Teton NP	9,300	Not flown	Not flown	--
Gallatin NF	256,100	20,316	37,500	1.8
Beaverhead NF	108,800	42,441	136,600	3.2
Custer NF	68,700	1,087	1,300	1.2
Bridger-Teton NF	115,000	34,373	131,100	3.8
Caribou-Targhee NF	56,000	1,982	3,900	1.9
Shoshone NF	232,000	41,746	43,700	1.0
Total	**1, 064,600**	**171,160**	**719,300**	**4.2**

Recently conducted research and observations over the past few years, suggest warmer-than-normal temperatures at high-elevation sites have increased MPB-caused impacts by increasing beetle survival and in some cases shortening their life cycles. Under more typical conditions over-wintering survival is reduced and population expansion is not as rapid (Nijhuis 2004). The situation existing in the GYE, however, is not limited to that geographic area. At present, WBP stands throughout the intermountain West are experiencing higher-than-normal levels of MPB activity—supporting the contention that recent climatic conditions have contributed to current outbreaks.

ADS data for administrative units in the GYE, obtained within the past 5 years, indicates MPB populations in WBP stands within that geographic area were at generally endemic levels as recently as 2000. While not all areas were surveyed every year, unusually high MPB populations have been recorded in most areas only during the past 4-5 years (Table 2). The Caribou-Targhee and Shoshone NFs showed building populations in 2000. Prior to 2000, for at least the preceding ten years, only minor amounts of beetle-caused mortality were recorded in most of the GYE surveyed (Unpublished office reports).

Table 2. Acres MPB-Infested WBP in GYE, 2000-2004 (ADS Data)*

Adm. Unit	2000	2001	2002	2003	2004
Yellowstone NP	Not flown	Not flown	11,814	15,086	Not flown
Grand Teton NP	Not flown	Not flown	Not flown	Not flown	Not flown
Gallatin NF	18	0	Not flown	9,014	47,844
Beaverhead NF	173	Not flown	30,263	38,891	29,978
Custer NF	0	0	73	533	1,762
Bridger-Teton NF	199	1,031	6,466	13,506	17,495
Caribou-Targhee NF	794	3,808	844	4,960	3,417
Shoshone NF	2,068	30,529	43,300	42,327	48,158

* Note: Yearly infestation acreage figures are not additive. Currently fading trees are often recorded on many of the same acres in succeeding years.

In support of ADS figures, we occasionally obtain ground-based data from a series of FINDIT (Bentz 2000) plots in a few selected beetle-infested stands. Plot data for most forested areas in GYE are not available; however, we did obtain some from a series of plots in Yellowstone NP and adjacent Gallatin NF in 2004. I believe these data are representative of MPB-caused mortality throughout the area within the past 2-3 years.

In twenty plots established in Yellowstone NP, near Avalanche Peak, WBP killed by MPB within the past three years averaged almost 96 trees per acre. On the Gallatin NF, where we established ten plots near Lightning Lake, mortality—most also killed within the past three years—averaged 162 WBP per acre. In the Yellowstone plots, beetle-killed trees represented 80% of the WBP over 5 inches (diameter at breast height) in surveyed stands. In the Gallatin plots, 74% of the WBP over 5 inches have been killed. In some areas, mortality levels have already begun to decline due to host depletion.

On the Shoshone NF, in 2005, ground-collected data in a few MPB-infested WBP stands showed beetle-caused mortality ranged from 7 to 41 trees per acre, most of which were currently infested trees. Total mortality, however; most of which has occurred within the past 1-3 years, is much higher (Allen, personal communication).

Atypically warm and dry weather, and stands that hadn't experienced significant disturbances (MPB outbreaks or fire) for a half-century or so, combined a few years ago to create conditions that fostered rapidly expanding beetle outbreaks in these highly susceptible habitats. Because timbered stands on these sites are rarely managed, at least in the silvicultural sense, epidemics will likely last as long as suitable hosts remain or until environmental conditions become less conducive to MPB survival and expansion.

WBP and MPB

While vulnerable to present conditions, WBP is one of the hardiest of the pine species, capable of surviving in extremely harsh environments. It plays a critical role in the ecology and sustenance of other members of their shared alpine communities; such as grizzly bears, Clark's nutcrackers, and red squirrels. In fact, present distribution of WBP is almost totally dependent upon Clark's nutcrackers—virtually the sole agents of seed dispersal, and fire-created openings in which seeds are cached (Tomback et al, 2001).

Disturbance is an integral part of these high-elevation ecosystems. Disturbances such as fire and MPB outbreaks, while not frequent, have shaped the landscape in these subalpine zones. Now, however, introduced pests, and native ones taking advantage of especially favorable conditions, are exposing WBP to combinations of threats it has never before encountered. Some WBP ecosystems have been so seriously damaged we question their ability to return to pre-settlement conditions.

While WBP sites were some of the last to be affected by human encroachment; a subtle, yet significant affect has been fire suppression. On some sites, stand composition has changed, stands have become overmature and more densely stocked, and the likelihood for more damaging fires has increased.

A much more drastic affect of human intervention than fire exclusion in many forested ecosystems has been the introduction of non-native pests. In WBP habitats, none have been more threatening to the long-term survivability of WBP than white pine blister rust. The development of WBP breeding programs to promote rust resistance hold some hope for future generations of WBP. They are described in more detail by Tomback and others (2001).

A more serious threat to WBP, however; at least in the short term, is a native pest—MPB. MPB outbreaks occasionally reach levels sufficient to kill millions of mature trees before running their course. And local climatic conditions may exacerbate an already bad situation. A few years of warmer- and drier-than-normal conditions enable beetles to kill WBP in unusually high numbers in a remarkably short period of time.

MPB outbreaks in the early part of the twentieth century were mostly recorded in hosts other than WBP. We often concluded MPB outbreaks in WBP were the result of outbreaks developing first in LPP stands at lower elevations, and more hospitable climates, then moving into WBP stands as LPP resources were exhausted. We know such phenomena did occur during MPB outbreaks in the 1970s (Parker 1973) and 1980s (personal observations).

Now, however, we believe some 1930s outbreaks may have developed in WBP; then moved down into LPP stands. We find that to be the case at many WBP sites today (Unpublished office reports). Similarities between historic and recent MPB outbreaks in WBP suggest a commonality is unusually warm yearly temperatures. United States' weather records show warmer temperatures for the 1930s than any other decade in the twentieth century—and very close to extremes we have experienced in the past 3-5 years (Anonymous 2006). It is reasonable to assume similar conditions in natural ecosystems, then and now.

As a result, MPB outbreaks today in WBP stands are at levels not previously quantified. Still, we know 1930s outbreaks were extreme. Furniss and Renkin (2003) quoted a 1934 report for Yellowstone NP, which stated: "The mountain pine beetle epidemic is threatening all of the white bark and lodgepole pine stands in Yellowstone Park. Practically every stand of white bark pine is heavily infested…and will be swept clean in a few years. If the insects spread from the white bark pine to the lodgepole stands, it seems inevitable that much of the park will be denuded."

Conclusion

Over the past few decades, we have learned much in not only coping with MPB, but in developing means to reduce beetle-caused mortality in some stands and situations. We know we can, in some host species, silviculturally create stand conditions less impacted by beetles (McGregor, et al 1987; Bartos and Amman, 1989). And we have learned to use beetle-produced pheromones to our advantage. Female-produced attractant pheromones have been used to manipulate beetle populations (Borden, et al 1983). Verbenone, the primary anti-aggregant pheromone produced mostly by male beetles, has been used successfully to protect high-value trees from beetle attack (Bentz, et al 2005; Kegley, et al 2003; Kegley and Gibson, 2004).

However, we have much yet to learn relative to silvicultural manipulations of WBP stands to reduce MPB-caused mortality. Some management alternatives may advantageously include the use of prescribed fire (Tomback, et al 2001). In the meantime, we have had good success in preventing attacks using preventive sprays of insecticides; and to a lesser, but still-valuable extent, verbenone has been useful.

As restoration projects are developed and implemented, it will be important to preserve mature cone-bearing trees from MPB depredations while beetle populations remain high. Plant pathologists and geneticists are developing breeding programs, similar to successful ones for western white pine, to forestall affects of white pine blister rust. Cone collections from trees resistant to blister rust, but susceptible to MPB, will be critical to the success of these programs. Combined efforts of entomologists, plant pathologists, silviculturists, and other resource specialists will be required if WBP is to be successfully preserved and restored to critical, high-elevation sites throughout its historic range.

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